The New Millennium Program: Management Challenges in the 21ST Century

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Abstract—NASA's New Millennium Program (NMP) will accelerate the infusion of technologies into its space and Earth science missions of the 21st century. The program plans a series of technology-validation flights in the 1998-2000 time frame, anticipating a rate of two flights per year, which will demonstrate technologies for deep space and Earth-orbiting missions.

In tandem with developing and validating new technologies, NMP is also undertaking new management approaches, particularly in the area of partnering between government and industry. A novel application of the concept of integrated product development teams (IPDTs) is being pursued: one in which cross-organizational teams, made up of members from government, industry, and academia, create roadmaps for development of the high pay-off technologies that NMP intends to flight validate. The IPDT approach is expected to reduce cost and improve product.

This paper discusses the management challenges< that must be addressed today in order to more efficiently undertake space exploration and Earth observation in the 21st century: the new millennium.

TABLE OF CONTENTS

1. INTRODUCTION

Given the nation's current fiscal environment, as well as public opinion regarding the space program, NASA's NMP is developing revolutionary new technology and pioneering innovative management practices to ensure a highly cost-effective space and Earth science program for the 21st century. "Faster, better, cheaper" has become the hallmark of the way NMP does business. Our challenge is to increase both the frequency of future missions and the rate of science data return, while simultaneously bringing down overall expenditures.

In the past, decisions governing the design and implementation of space missions were made hierarchically and sequentially by discrete groups of people who worked toward individual goals. Now, new management techniques of concurrent team decision-making have been created to emphasize a common end goal of lower cost and better-quality product, and the larger picture, that of enhancing humankind's information

about the universe, is being focused upon. Under the aegis of NMP, government, industry, and academia will partner in such a way that decision-making toward a common goal will be made concurrently by representatives from each area.

2. Management Concept Change with Industry

NMP is focusing on and planning to improve specific aspects of the government–industry relationship through (he following three actions:

- Early industry involvement
- Getting on contracts more quickly
- Shifting the government--industry interface.

Early Industry Involvement

Integrated Product Development Teams—-l-he concept of integrated product development teams (IPDTs) has recently been successfully applied throughout much of private industry. An IPDT is generally formed within a company by bringing together members from its manufacturing, sales, and operations personnel to look at a product in a total, integrated sense: Concurrent. sales and service feedback of a product while it is being designed and manufactured is typical of what an 1 PDT can accomplish, and this has proven to be very effective in product designing and deploy merit..

Automotive and aircraft companies are good examples of private industry organizations whet-c IPDTs have been highly effective in simultaneously improving the quality of a product while reducing its cost [1]; customer satisfaction is thus increased by a considerable margin. So, though it is often difficult for personnel to work together across departmental barriers in an organization, it is evident that the IPDT approach of cross-departmental representation and input toward developing a product allows for significant quality and cost improvement of that product.

New Millennium ***Program*** *IPDTs*—NASA's NMP has taken the concept of IPDTs beyond the interdepartmental organizational level and applied it to a higher level, one that reaches across *organizations*, where barriers have traditionally been harder to surmount. NMP has formed IPDTs among government, industry, and academia, giving the teams the mandate to develop roadmaps for specific technologies and to bring those technologies to a scheduled state of readiness for flight validation by the program. By setting a higher, "global" goal, as it were, rather than an individual-member '(local" goal, the 11 'DT members work together with a mutual understanding of each other's preferences and of the obstacles each may face. "Multifunctional teams establish the structure that brings the necessary people . . . into real-time contact to accelerate the speed of learning. [They] provide a comi non fot urn for overlapping problem solving." [2]

For instance, in the area of design, it is the prevailing belief that design teams can work together without requiring that their members be physically collocated in order to modify or change existing designs and create a final product. In contrast, NMP believes that if there is intensive ci eative design work involved, for a project such as sending a spacecraft to Jupiter or Pluto, it is extremely important that design team men ibers be in close physical proximity and have constant verbal contact. NMP views creative design as a contact sport, as it were, and believes the best results emerge from physical cent act and joint teamwork toward a single goal.

Industry Involvement with NMP IPDTs—NMP is placing particular focus on involving industry early in government's technology development cycle, to allow the commercialization component into the process and realize a more mutually cost-beneficial technology development plan from the start. Academia, too, is being exposed to government technology needs earlier so that its t nembers can steer research programs ac - cordingly.

The NMP IPDTs — composed of eight to ten members each in the areas of Autonomy, Communications Systems, Microelectronics Systems, Instruments and Microelectromechanical Systems (MEMS), and Modular and Multifunctional Systems — are functioning extremely well in breaking down historical barriers between industry and government to produce a "win-win" product for everyone. Many of the questions voiced early on in the formation of the IPDTs, such as team size, change of leadership or membership, frequency of meetings, cross-team fertilization, and intellectual rights, have been addressed and resolved by the teams themselves. An important philosophy used in this respect was to set Up these teams in a self-governing mode and allow them to develop the means to deal with these kinds of problems "Vertical compression means that at points in the process where workers used to have to go up the managerial hierarchy for an answer, they now make their own decisions. Instead of separating decision-making from real work, decision-making becomes *part* of the work." [3]

As members of the IPDTs, industry representatives are involved early on in developing technology roadmaps so they can influence those features that are of industry-particular importance from the very beginning. Such considerations as whether or not a product is manufacturable, or whether it can be reproduced in a standardized model, may cause final product performance to fall short of an expected ideal, but when recognized for their specific commercial importance to industry these considerations may be more acceptable to all IPDT members. It is to NASA's benefit in the long run if commercial application of technology is enhanced and expedited; reduced cost and improved reliability of products are good examples of such benefits.

Each NMP technology-validation flight team will have an industry member who will be selected as early on in the flighl-concept development cycle as possible. Though this somewhat complicates the development process — in the sense that without a comprehensive mission or spacecraft design it is difficult for the industry member to propose a realistic implementation cost — NMP believes that the sooner the industry partner can be involved in the mission and spacecraft design, the more the partner can contribute to proposing a highly cost-effective implementation tailored to his capabilities. We are selecting industry partners as early as possible, albeit without a definitive scope of work, using their overall performance capability (past and ongoing) as a gauge. Experience tells us that personnel capability is the most critical element to mission success.

NMP Workshops—NMP will conduct annual technology workshops for the sole purpose of continually bringing new players and ideas to the forefront. The IPDTs will present the current versions of their roadmaps, technology-validation flight plans, and any flight or ground test results at these workshops, which are expected to provide crois-fertilization among the IPDTs as well as increase interactions among government, industry, and academia.

Getting on Contracts More Quickly

Industry partners for both the IPDTs and the flight teams will be selected according to their capabilities, rather than by their ability to write proposals for specific design implementation. This approach reduces the amount of work the government has to do in preparing a Request for Proposal (RFP) and in evaluating responses, and reduces the work industry has to do in responding to an RFP. Not only is the work of both parties significantly reduced, but the time spent by NMP to get on contract is reduced to a bare minimum. For example, 230 companies submitted proposals for membership in the NMP IPDTs; 24 were selected and on contract (this includes full negotiations) within eight weeks.

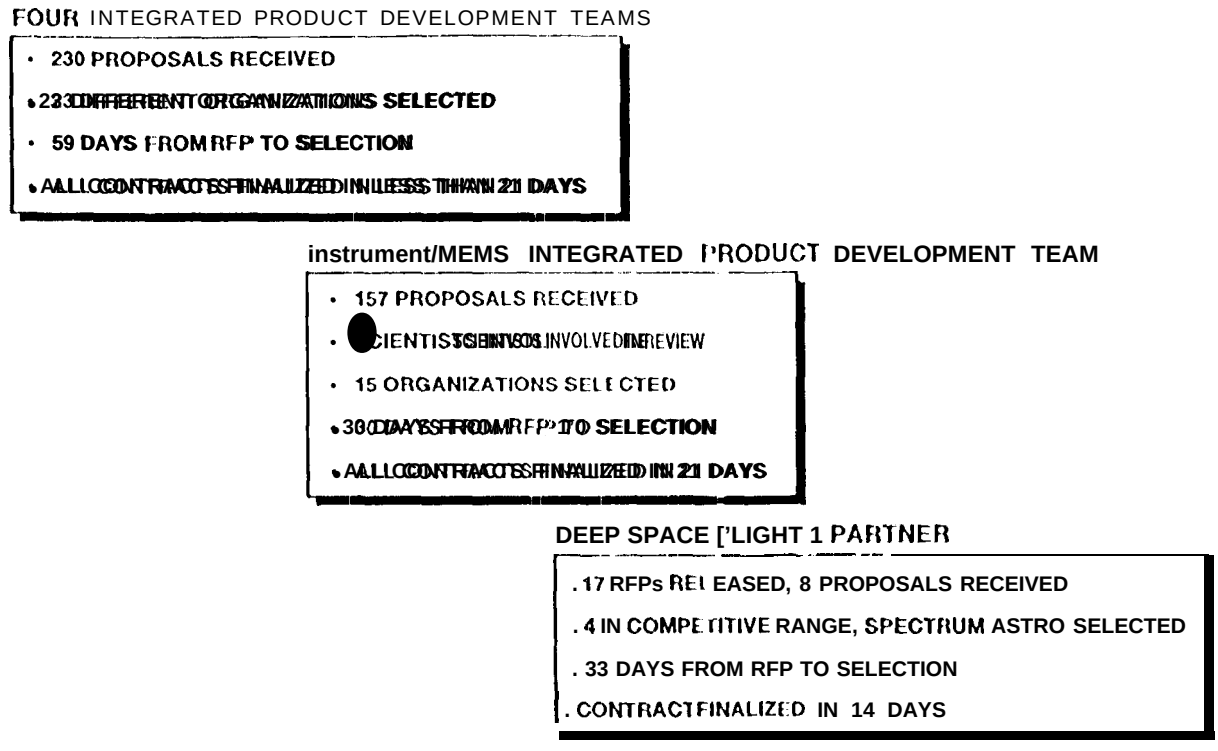

Figure 1. NMP Procurement Accomplishments

Figure 1 summarizes the specific times NMP spent getting on contract for both the IPDTs and the first technology-validation flight. It can be seen that these times are five to ten times shorter than those for typical contracting practices.

Shifting the Government-Industry Interface

In past decades, NASA invested heavily in building a strong infrastructure within industry so that it could provide the technology needed to execute NASA's space missions. We must now capitalize cm this investment, which has developed to a point where implementation of space missions can be turned over to industry, allowing these capabilities to function within the constraints of the free market. Government should back away from the implementation aspects of the space program and concentrate more on the re.search and development of the technology needed for implementation. Ideally, government and industry should have a working relationship wherein the specific strengths of each are combined in a way that government funds are used most cost- effectively, keeping in mind the public's best interest. [4]

Government should focus on developing those technologies that are too expensive for any one member of industry to undertake, or that are needed only by the government and do not in general have little if any potential market appeal. The National Advisory Committee for Aeronautics (NACA) and the Atomic Energy Commission (AEC) laboratories are good examples of how the government spearheaded the development of the aircraft and nuclear industries in the early 1950s. These efforts required significant government monies --- sums that were out of reach of industry --- for laboratories and test facilities. For example, the NACA laboratories researched basic aircraft design theoretically and experimentally through high-cost wind-tunnel testing. Through this high-cost research,

the aircraft industry built a strong, self-sufficient, and highly competitive infrastructure, and single organizations within industry began to acquire the know-how and technology capabilities for aircraft development.

With the advent of the space program and the start of space exploration in the 1960s, the aircraft industry laboratories were already in place with the needed technologies to help implement the space missions, and were converted to NASA laboratories. Also as a consequence of the earlier developmental activities, the technology requirements needed for the rapid expansion of the Apollo program in the 1970s were easily satisfied through the industry laboratories.

3. Conclusions

The **New** Millennium Program is breaking new ground in developing and flight validating the revolutionary technologies and capabilities that will be used in ambitious future space and Earth science missions. NASA's plan is to ensure increased frequency of future missions, higher science data return, and reduced mission costs. Innovative management techniques and methods of teaming are part of the new ways of doing business in implementing the nation's science mission goals. NMP's IPDTs operate across organizations — government, industry, and academia --- with members working together to break down traditional barriers and to quickly move from technology research to design and application, to implementation in validation flights.

Emphasis on involving industry early in the development cycle allows a mutually cost-beneficial effort from the start, with time needed to get on contract considerably shortened compared with traditional methods. As government concentrates on research and development, allowing industry to implement missions, their combined strengths will ensure a more cost-effective use of public funds in carrying out the nation's science endeavors.

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Biography

E. Kane Casani is currently the manager of NASA's New Millennium Program (NMP), which is part of the Space and Earth Science Programs Directorate at the Jet Propulsion Laboratory of the California institute of Technology. In his capacity as manager of NMP, he is developing the concept of exploration for the new millennium. NMP will develop and validate the essential technologies and capabilities required for 21st-century space missions. Prior to this assignment, Mr. Casani was manager of the Project Design and Strategic Planning Office, which implemented and managed the Flight System Testbed and the Project Design Center at JPL.